**Lecture 20 – Circulatory and Respiratory System**

In this lecture, you will learn why animals breathe and how body’s transport system works.

* Animals depend on oxygen because (it is a chemical fuel for cellular respiration)

- This is fundamentally important because all cells need fuel.

Glucose example) C6H12O6 + **6 O2**🡪 6 CO2 + 6 H2O + Energy (ATP + heat)

* Animals engage in constant gas exchange (respiration) with the environment.

\* Gas exchange is different from the energy transformation of cellular respiration.

* Gas exchange must take place across moist respiratory surfaces by **diffusion**.

\* All respiratory surfaces have large surface areas.

Mammals have (lungs).

Insects have (tracheal system 🡪 network of pipes inside body and little holes in abdomen).

Fishes have (gills).

* Mammals ventilate by negative pressure breathing powered by (diaphram).

You need to know how diaphragm moves when you inhale or exhale.

\* Ventilation: movement of the respiratory medium (O2 and CO2) over the respiratory surface (lungs)

* You need to know each component of human respiratory system. Learn the names in Figure 42.25 (p. 919).

Air travels through

(larynx) 🡪 (trachea) 🡪 (Bronchi) 🡪 (Bronchioles)🡪 (Alveoli).

Alveoli are where gas exchange occurs in mammals.

* Circulatory system is a transport system.
  + It delivers (O­2), (CO2), (nutrients), and (waste).
  + It consists of three components: circulatory fluid (blood), interconnecting tubes (blood vessels), muscular pump (heart).
* **Blood** consists of cells suspended in plasma
  + Plasma: water, ions, plasma proteins, substances transported by blood (nutrients, wastes, respiratory gases, hormones)
  + White blood cells (leucocytes): defense and immunity
  + Platelets: blood clotting
  + Red blood cells (erythrocytes): transport of O2 (via hemoglobin)
* **Blood vessels** carry blood between heart and organs. (You need to know the characteristics of arteries and veins. Study Figure 42.10 [p.905])
  + Arteries: carry blood away from heart to organs
    - Typically thicker
    - Flap inside to prevent blood from going back
  + Veins: carry blood from organs back to the heart
    - Typically thinner
    - Powered by skeletal muscle

\* The vessels are defined by direction of blood flow, not by their oxygen content.

* **Heart** is a muscular pump powering blood circulation.
  + Mostly cardiac muscle
  + Human heart is four-chambered (right and left atria, right and left ventricles)
  + Contract and relax in a rhythmic cycle

\* You must know how blood flows in human circulatory system starting from right ventricle. Study Figure 42.6 (p. 902) and follow the circled numbers.

* Human heart rate is about (72) beats per minute.
  + Cardiac cycle: one complete sequence of pumping and filling (about 0.8 second)
  + Systole = contraction phase
  + Diastole = relaxation phase
* Heart rhythm is maintained by pacemaker.
  + Sinoatrial (SA) node: sets the rate and timing of cardiac muscle cell contraction
  + Atrioventricular (AV) node: relay point
  + affected by nerves, hormones, body temperature, and exercise
* Blood flow velocity and blood pressure vary throughout circulatory system. (Understand why there are variations in the velocity and pressure. Study Figure 42.11 (p. 906) if unclear).
  + Velocity: fastest in (arteries), slowest in (capillaries), medium in (veins)
  + Blood pressure: highest in (arteries), lowest in (veins), medium in (capillaries)
* Blood flow in capillaries controlled by (precapillary sphincters).
  + At any given time, only about 5-10% of the capillaries have blood flowing through them
  + Only vital organs (brain, heart, kidneys, liver) are filled to capacity
* Blood flow in veins is powered by (skeletal pumping).
  + One way valves keep blood moving toward heart
  + If malfunctions, result in varicose veins
* Open vs. closed circulatory system

1. Open circulatory system

\*\* The circulatory system and respiratory system is disconnected

* + Arthropods and most molluscs
  + Hemolymph bathes body cells

1. Closed circulatory system

* Annelids, cephalopods, and all vertebrates
* Blood is confined to vessels, heart pumps blood
* Single vs. double circulatory systems in vertebrates

1. Single Circulation: fishes
   * Blood passes through two capillary beds before returning to heart
2. Double Circulation: amphibians, reptiles, and mammals
   * Two separate circuits (pulmonary and systemic)